UNITED STATES ARMY AVIATION BOARD
Fort Rucker, Alabama

ATBG-ACAB-AVN-4062

11 JUN 1962

SUBJECT: ~~Report of Test, Project No. AVN-4062,~~ "Informal Evaluation of the Navy HSS-2 Helicopter"

TO: Commanding General
United States Continental Army Command
ATTN: ATDEV-6
Fort Monroe, Virginia

1. AUTHORITY.

a. Directive. Letter, ATDEV-6 452.1, Headquarters, USCONARC, 15 March 1962, subject: "Evaluation of the Navy HSS-2 (Sikorsky) Helicopter."

b. Purpose. To conduct an informal evaluation of the Navy HSS-2 Helicopter to determine tactical capabilities and flight characteristics.

2. BACKGROUND.

a. The Sikorsky HSS-2 (Army S-61A) was designed and built by the US Navy under the Weapons System Concept. Following Navy preliminary evaluations, Bureau Inspection and Survey Trials, the HSS-2 was approved for anti-submarine duty in the fleet, 1 September 1961. FAA certification of the S-61A was granted 2 November 1961. As of 28 February 1962, 92 helicopters were flying and a total of 13,268 flying hours had been logged.

b. The test helicopter, Navy HSS-2, Bureau Number 149006, was obtained on bailment from the US Navy and was then bailed to the manufacturer, Sikorsky Aircraft, Division of United Aircraft Corporation, Stratford, Connecticut. Arrangements were made for manufacturer's

representatives including pilots, engineers, and maintenance crewmembers, to tour various Army installations and demonstrate the capabilities of the helicopter. The portion of the demonstration at Fort Rucker was expanded to include an informal evaluation by the US Army Aviation Board of performance characteristics and capabilities. Personnel from the US Army Airborne, Electronics and Special Warfare Board (USAAESWBD) evaluated the troop and internal and external cargo-carrying capability of the HSS-2 at Fort Bragg, North Carolina. The USAAESWBD report is attached as inclosure 1.

3. DESCRIPTION OF MATERIEL. The HSS-2 Helicopter is designed for Navy use for both shore and shipbase operations to detect, identify, track, and destroy enemy submarines. For this mission, the helicopter carries sonar, automatic stabilization, AN/APN-130 radar navigation (Doppler) equipment, and depth charges.

a. The HSS-2 is configured as a single main-rotor helicopter and is powered by two General Electric T58-CE-8B axial flow gas-turbine engines. Emergency amphibious landing gear is composed of a flying boat-type hull bottom and two outrigger sponsons, into which dual main landing wheels can retract. A fixed tail wheel is located on the after end of the hull. The fuselage is of all-metal semi-monocoque construction and is comprised of five sections: the forward fuselage section, the hull, the after fuselage section, the tail cone section, and the pylon.

(1) The forward fuselage section and hull contain the electronics-radio compartment, the pilot's compartment, engine compartment, transmission compartment, cabin, and fuel tanks.

(a) The electronics-radio compartment is located in the forward portion of the hull.

(b) Above the electronics-radio compartment, and forward of the cabin, is the pilot's compartment which is entered from the cabin.

(c) The engine compartment is located above the forward portion of the cabin. The two turbine engines are mounted

side by side in the engine compartment with the engine shafts extending aft into the main gear box.

(d) Directly aft of the engine compartment is the transmission compartment, housing the main gear box. The main-rotor assembly, to which the five main-rotor blades are attached, is splined to the main-gear-box drive shaft. Shafting extends aft from the main-gear-box lower housing to the intermediate and tail gear boxes to drive the tail rotor.

(e) Directly below the engine and transmission compartments is the cabin. The cabin is 19 feet 3 inches long, 6 feet 6 inches wide, and 5 feet 10 inches high and may be entered either through a sliding cargo door on the right after side of the cabin or through a hinged personnel door on the left side of the cabin. The sonar equipment and operator's station were removed from the test helicopter to allow the installation of 25 troop seats, and a temporary plywood floor incorporating tiedown rings was installed to provide cargo-loading and restraint facilities. An additional four inches of insulation was installed around the cabin interior for improved noise attenuation.

(f) Two multicell fuel tanks are installed in the hull below the cabin floor.

(2) The after fuselage section and the tail cone section extend aft from the rear cabin bulkhead. A tail-rotor de-icing controller and the compass valve and compensator are the only pieces of equipment installed in the tail cone.

(3) A horizontal stabilizer is installed on the upper right-hand side of the pylon. The intermediate gear box is installed in the lower portion of the pylon with a shaft extending upward to the tail rotor gear box at the top of the pylon. The five-bladed tail rotor is splined to the tail-rotor gear box.

(4) To facilitate parking, the five main-rotor blades may be folded parallel to the fuselage, and the pylon can be folded forward along the right side of the tail cone.

b. Dimensions and weights of the HSS-2 are listed below:

(1) Dimensions.

Length:	
Maximum, main-rotor blades extended	72 feet 6 inches
Minimum, main-rotor blades and pylon folded	46 feet 6 inches
Height:	
Maximum to top of anti-torque rotor blade	16 feet 8 inches
Minimum, pylon folded	16 feet 8 inches
Width:	
Maximum, main-rotor blades extended	62 feet 0 inches
Minimum, main-rotor blades and pylon folded	15 feet 8 inches
Main rotor diameter	62 feet 0 inches
Anti-torque rotor diameter	10 feet 0 inches
Minimum main-rotor ground clearance (tip clearance - forward sector)	12 feet 1 inch
Minimum anti-torque rotor ground clearance	6 feet 8 inches
Main landing gear tread	13 feet 0 inches
Ground clearance (bottom of fuselage)	1 foot 6 inches

(2) Weights (approximate).

Empty	11,000 pounds
Normal gross	17,000 pounds

Maximum gross (Navy limitation)	19,000 pounds
Overload gross	21,000 pounds
Normal fuel capacity	4,500 pounds
Payload, 100-nautical-mile radius of action	5,000 pounds

4. TESTS. The HSS-2 was flown by aviators of the US Army Aviation Board for a total of 20 flying hours in the vicinity of Fort Rucker, Alabama, during the period 26 March - 30 March 1962. Tactical suitability was determined insofar as was possible with the equipment available; a litter kit and external cargo hook were not available for test; however, a cargo hook was installed in time for evaluation at the USAAESWBD at Fort Bragg.

a. General.

(1) Cockpit Configuration. Cockpit configuration was generally satisfactory. The following were noted:

(a) Entrance to the pilot's seats was restricted by the radio console and the flight controls; however, a properly located hand-assist handle aided entrance and egress. The emergency exits were adequate.

(b) Seat adjustments were satisfactory. The seat configuration, however, was not optimum for pilot comfort, lacking contour and proper support for the pilots' backs. A thicker seat cushion was needed to relieve discomfort caused by the weight of the pilots' legs resting on the seat structure.

(c) Visibility was optimum with the exception of a small area forward and down from the pilots' stations. During approaches a side-slip was used when increased visibility was needed.

(d) Flight control forces, trim adjustments, and friction devices were satisfactory.

(e) All necessary switches and controls were within reach of both pilots with the exception of the manual engine controls to be used in the event of engine governor failure which were located overhead within reach of the copilot only.

(f) The instruments provided were adequate for instrument flight with the exception of the vertical speed indicator which was too small and fluctuated excessively.

(g) The overhead throttle configuration was adequate; however, frequent adjustment by the copilot was necessary during maneuvers requiring power changes.

(2) Overall Configuration.

(a) The following undesirable characteristics were noted:

1. The tip path plane of the main rotor is in close proximity to the tail boom when the cyclic is placed in the after position, and there has been at least one HSS-2 accident occurring as a result of the main blades contacting the tail boom. Maneuvers such as tail-low landings using aft cyclic for braking action; taxiing or landing on rough terrain; hovering turns in strong, gusting winds; or abrupt decelerations would be inherently hazardous. This characteristic seriously detracts from the suitability of the HSS-2 for tactical operations in unprepared or confined areas.

2. The cargo-loading door on the test helicopter was approximately five feet wide and inadequate for accepting bulky cargo. An 11-foot-wide door is proposed for improved cargo loading; however, the aft side-loading provision is less desirable than loading from the rear such as with the Caribou or the Chinook, or loading from the side at the approximate center of gravity such as with the H-34. A turn-table device with ramp for loading jeeps or other lengthy cargo is proposed by the manufacturer; however, the equipment is not yet past the design stage. The cabin floor is at approximate truck bed height for loading convenience; however, a ramp or loading device of some type would be needed for loading heavy cargo from the ground.

3. There were no provisions for an internal auxiliary power unit to provide self-sufficiency in the field.

4. No litter kit was provided in the test helicopter although the manufacturer indicates a kit has been developed.

5. There was no ventilation provided for the cabin area.

6. There were insufficient windows (three) in the cabin area.

7. There were no blackout provisions.

8. The additional four inches of sound proofing material which was added to the test helicopter throughout the walls and ceiling of the cabin area reduced the noise level to a low degree (see paragraph (c) below); however, the cabin dome lights were recessed in the soundproofing and were ineffective.

(b) The following was found to be satisfactory:

1. Ground handling by use of tug and by taxiing on smooth surfaces.

2. Ease of servicing.

3. Exterior and pilot compartment lighting.

4. Blade-folding capability which enhanced parking and camouflage operations.

(c) The following noise levels were determined and were considered satisfactory:

INTERIOR NOISE LEVEL - DECIBELS

Audiometer Scale	Cabin	Center	Rear
A	84	85	83

Audiometer Scale	Cabin	Center	Rear
B	88	93	90
C	96	97	97

Note: Four inches of additional insulation were installed in the cabin area.

EXTERNAL NOISE LEVEL - DECIBELS

Audiometer Scale	Hover	Takeoff	Approach	Fly-By
A	80	88	83	80-90
B	88	90	90	
C	94	92	94	

(d) An adequate Flight Manual was provided (NAVWEPS 01-230HLC-1, revised 1 December 1961).

(3) Air Transportability. The manufacturer's brochure stated that the HSS-2 could be partially disassembled and transported in U. S. Air Force cargo-type airplanes as follows: one HSS-2 in a C-130, one in a C-124, and two in a C-133. The degree of disassembly necessary for transport in the C-130 is quite extensive.

b. Flight Characteristics and Performance.

(1) With the exception of the undesirable characteristic discussed in (2)(a)1. above, the flight characteristics of the HSS-2 were determined to be very satisfactory. The vibration level at airspeeds up to 150 knots was comfortably low. Vibration during transition to and from forward flight was noticeable but was considered to be acceptable. Control travel, feel, and response were satisfactory. The following maneuvers were performed with the helicopter at various gross weights up to 19,200 pounds at takeoff.

(a) Normal takeoffs and landings

(b) Running takeoffs and landings

(c) Maximum performance takeoffs and steep approaches

(d) Decelerations

(e) Autorotations

(f) Steep turns

(g) Hovering and hovering turns

(h) Forward and sideward flight in ground effect

(i) Cruising flight up to 150 knots indicated airspeed

(j) Settling with power

(k) Slope landings to 10 degrees

(l) Flight with primary servo system off.

(2) Performance. The following performance data were determined:

(a) Climbs. Climbs using maximum performance power were made to an altitude of 12,000 feet with the helicopter at approximate gross weights of 17,000 pounds and 19,000 pounds. The following table summarizes the climbs.

Density Altitude (Feet)	Rate of Climb (Feet Per Minute) Gross Weight 17,000 Pounds	Rate of Climb (Feet Per Minute) Gross Weight 19,000 Pounds
2000	1900	1800
3000	1750	1500

Density Altitude (Feet)	Rate of Climb (Feet Per Minute) Gross Weight 17,000 Pounds	Rate of Climb (Feet Per Minute) Gross Weight 19,000 Pounds
6000	1600	1100
9000	1350	800
12000	950	500
13000	800	250

(b) Hover. Hovering ceiling at 17,000 pounds gross weight was approximately 5500 feet density altitude. Hover out of ground effect under existing atmospheric conditions could not be accomplished when the helicopter gross weight was 19,000 pounds.

(c) Maximum Speed. The maximum indicated airspeed attainable in level flight was determined at various altitudes with the helicopter at two different gross weights. Placarded maximum airspeed was 150 knots. The following data were recorded:

Gross Weight At Takeoff (Pounds)	Density Altitude (Feet)	Outside Air Temp. (°C.)	Indicated Airspeed (Knots)
17,000	1700	18	150
17,000	3800	14	150
17,000	6600	7	150
17,000	13000	0	95
19,000	1800	19	150
19,000	3800	14	150
19,000	6900	8	130
19,000	13000	-1	75

(d) Range.

1. A determination was made of approximate zero-wind range with no reserve by noting fuel consumption, true airspeed, and fuel available (4500 pounds). The following data were recorded:

Gross Wt. At Takeoff (Pounds)	True Airspeed (Knots)	Fuel Consumption (Lb./Hr.)	Endurance (Hours)	Approximate Range (Naut. Mi.)	Density Altitude (Feet)	Outside Air Temp. (°C.)
19,190	115	1000	4.5	518	800	12
19,190	90	818	5.5	495	800	12
17,000	127	1000	4.5	572	1200	15
17,000	102	818	5.5	562	1200	15

The above data compared favorably with range data published in the Flight Manual, NAVWEPS 01-230-HLC-1.

2. From the above figures, it can be calculated that a payload of approximately 5000 pounds could be transported a distance of 200 nautical miles at a true airspeed of 115 knots with a 30-minute fuel reserve and a crew of three.

(e) Autorotations. The slowest autorotative rate of descent with the helicopter at a takeoff gross weight of 19,100 pounds was determined to be approximately 2000 feet per minute at a density altitude of approximately 2000 feet. The slowest rate of descent was obtained at an indicated airspeed of 65 knots.

(f) Single Engine. Performance with one engine inoperative was investigated. The loss of one engine resulted in an automatic increase in power of the remaining engine to allow the pilot time to adjust to the new condition. Cruise and landing characteristics with one engine inoperative were satisfactory up to maximum gross weight. Service ceiling with the helicopter at a takeoff gross weight of

19,000 pounds and one engine inoperative was determined to be approximately 5000 feet density altitude, and approximately 5800 feet density altitude at 17,000 pounds takeoff gross weight.

(3) Instrument Flight. Hooded instrument flight was performed by rated helicopter instrument pilots during which the instrument flight characteristics were determined to be suitable. Flight instruments were provided for both pilot and copilot.

(4) Water Operation. Water operations were performed satisfactorily. The helicopter was landed on, taxiied over, and taken off from a lake surface. The water operation of the HSS-2 is described in the flight manual as an emergency capability and forward motion during landing should not exceed 20 knots. Single-engine landings were satisfactorily made by entering the water in a descending attitude while maintaining a 20-knot apparent ground speed. Maneuverability on the water was good; however, use of the cyclic control was needed for lateral stability.

(5) Night Flight. The HSS-2 was flown at night and was found to be satisfactory with the exception of the lack of blackout provisions. Approaches to unlighted fields were satisfactorily made utilizing the controllable searchlight and flood-hover lights. Instrument lighting was adequate.

c. Pilot Training. Lack of time precluded a complete pilot training program; however, it was determined that familiarization training on cockpit and emergency procedures required less time by comparison than that required for the H-37. It was estimated that a minimum of 10 hours of flight and two hours of classroom instruction would be necessary to complete a checkout for rotary-wing qualified Army aviators.

d. Doppler Navigation. The Ryan AN/APN-130, coupled with the Automatic Stabilization Equipment (ASE) and ASA-13 Computer and Plotting Board, was subjected to an evaluation flight during which a typical navigation mission was performed.

(1) The navigational accuracy was found to be approximately ± 5%, i.e. for a mission leg of 20 miles, an inaccuracy of one mile could be expected.

(2) Plotting board scales were unsuitable for Army use. Substitution of scales of 1/25,000, 1/50,000, and 1/250,000 would be necessary to accommodate current Army tactical charts.

(3) From an examination of the installation, retrofit to current Army helicopters does not appear to be practical from an engineering standpoint.

(4) The navigation system was compatible with the ASE and the AN/APN-117 radar altimeter installed.

e. Mission Suitability. This part of the test was conducted in conjunction with USAAESWBD, and results are contained in inclosure 1.

5. CONCLUSIONS.

a. The tactical capability of the HSS-2 Helicopter is severely restricted, primarily by its unsatisfactory cargo-loading provisions and the inherent hazard of the main-rotor blades contacting the tail boom.

b. The flight characteristics of the HSS-2 Helicopter are satisfactory except for the restrictions to certain flight maneuvers imposed by the possibility of the main-rotor blades contacting the tail boom.

6. RECOMMENDATIONS. It is recommended that:

a. No further consideration be given to the HSS-2 Helicopter in its present configuration for Army use.

b. The HSS-2 Helicopter be re-evaluated if the helicopter is modif ed to eliminate the restrictions noted in paragraph 5. a.

ATBG-ACAB AVN 4062
SUBJECT: Report of Test, Project No. AVN 4062, "Informal Evaluation of the Navy HSS-2 Helicopter"

7. REFERENCE. Flight Manual, Navy Model HSS-2 Helicopter, NAVWEPS 01-230HLC-1, revised 1 December 1961.

1 Incl
as

JACK L. MARINELLI
Colonel, Artillery
President

HEADQUARTERS
U. S. ARMY AIRBORNE, ELECTRONICS AND SPECIAL WARFARE BOARD
Fort Bragg, North Carolina

22 May 1962

REPORT OF PROJECT NR IAB 22-62

"EVALUATION OF THE NAVY HSS-2 HELICOPTER"

1. AUTHORITY:

a. Directives:

(1) Letter, ATDEV-6 452.1, USCONARC, 15 March 1962, subject: "Evaluation of the Navy HSS-2 Helicopter."

(2) Paragraph 4f, Disposition Form, ATBF-AB, this Board, 2 April 1962, subject: "Report of Trip - Ft Rucker, Ala, 28-30 Mar 62 (HSS-2)."

b. Purpose: Determine the air transport capability of the Navy HSS-2 Helicopter.

2. DESCRIPTION: The Navy HSS-2 is an amphibious, twin turbine, single rotor helicopter with an empty weight of 10,847 pounds and a gross weight of 19,000 pounds. The passenger/cargo compartment is 23' 11" long, 78" wide, and 75½" high with a side loading cargo door 5'8" wide and 5' high.

3. SUMMARY OF TESTS:

a. The test item is satisfactory with respect to:

(1) Internal transport of personnel (Test Nr 2).

(2) External transport of equipment (Test Nr 3).

b. The test item, in its present configuration, is unsatisfactory with respect to internal transport of supplies and equipment (Test Nr 2).

4. DISCUSSION:

a. Sikorsky has a proposal which will increase the width of the cargo door to 11' and provide loading ramps to permit ¼-ton truck and trailer size loads to be loaded internally. Their proposal will also provide for a "lazy suzan" or "turntable" in the cargo compartment to assist

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in loading vehicles. While the "lazy suzan" or "turntable" installation will expedite loading of wheeled vehicles, it probably will be in the "nice-to-have" category. The cost, weight, and complexity of the installation may outweigh its overall usefulness.

b. Even with these additional features, side door loading is more difficult and time consuming than straight-in loading.

c. Manhandling of ¼-ton size vehicles, around corners, is possible and has been done many times in the past.

d. There are no means for parachute delivery of personnel or supplies. The only apparent obstruction to parachute delivery of personnel and supplies, using a locally fabricated anchor line, is an antenna installation located on the starboard side of the helicopter, aft of the cargo door. The manufacturer stated that relocating the antenna installation would pose no problem.

5. CONCLUSIONS:

a. The HSS-2, in its present configuration, does not have a suitable air transport capability.

b. The HSS-2, when modified to include floor tiedowns, vehicle loading ramps, and a larger cargo door, will have a useful air transport capability of Army personnel, supplies, and equipment.

ANNEX:
A - Details of Test

ANNEX A - DETAILS OF TEST

REPORT OF PROJECT NR IAB 22-62

Tests were conducted by Captain Harold E. Fuqua, Mr R. G. Snodgrass, and other personnel from this Board.

1. TEST NR 1

a. Purpose: Determine the physical characteristics of the test item as pertains to air transport.

b. Method: The test item was measured. Technical data provided by the manufacturer were reviewed.

c. Results:

(1) General characteristics:

Basic weight	10,847 lb
Normal gross weight	19,000 lb
Alternate gross weight	22,000 lb
Useful load	8,153 lb
Engines	2 - General Electric T58-8
Normal cruise speed	125 K
Service ceiling	13,000'
Crew (normal)	3

(2) Dimensions:

(a) External:

Fuselage length	54'9"
Fuselage width	7'1"
Height (overall)	16'8"
Main rotor diameter	62'0"
Tail rotor diameter	10'0"
Main landing gear tread	13'0"

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(b) Internal:

Cargo/cabin length	23'11"
Cargo/cabin width	78"
Cargo/cabin height	75½"
Height of cargo floor above ground	47 3/4"
CG range	Sta 258 to 276
Cargo door width	5'8"
Cargo door height	5'

(3) Troop capacity:

Troop seats	28
Litters	18

(4) External hook characteristics:

Name of manufacturer	Eastern Rotorcraft
Capacity and type	6,000 #4 point suspension, open throat
Distance below helicopter	4' (Approx)
Master switch setting	Sling-safe-automatic
Release	Pilot and copilot
Length of cargo hook throat	10"

2. TEST NR 2

a. Purpose: Determine the suitability of the test item for internal transport of troops and supplies.

b. Method:

(1) Internal transport facilities were reviewed.

(2) Personnel and supplies were loaded, restrained, and unloaded.

c. Results:

(1) There is a crew access door with built-in steps on the forward port side and a 5'8" wide cargo door on the rear starboard side of the test item.

(2) There are 28 seats with safety belts. The 3-man seat section in front of the cargo door acts as a troop seat - step combination. There is stowage space under the seat for man-portable equipment. Space is available in the center of the test item to carry crew-served weapons and/or supplies when transporting troops.

(3) The test item furnished for evaluation had a plywood covered floor with an improvised tiedown grid consisting of five rows of tiedowns. No tiedown equipment was furnished with the test item. MC-1, 5,000-pound straps, and 10,000-pound capacity cargo nets were used to restrain the loads. Adequate restraint was not possible due to limited strength in the improvised tiedowns. However, assuming that this helicopter, if procured, would be equipped with outside tiedown rows of 5,000-pound capacity and inner rows of 2,200-pound capacity, the loads could then be restrained satisfactorily for a 4 G forward, 2 G aft, 2 G vertical, and 1.5 G lateral restraint factor.

(4) The following loads were loaded, restrained, and off-loaded with no difficulty:

(a) 127 - 5 gallon water cans - 5,715 lb.

(b) 18 - 55 gallon drums - 8,100 lb.

(c) 180 cases of C-rations - 6,840 lb.

(d) *26 combat equipped troops - 5,360 lb.

*This load was flown.

(5) Cargo was loaded into the test item from the beds of 2½-ton trucks, small forklifts, and from the ground.

(6) The size and location of the cargo door precluded loading of wheeled vehicles inside the cargo compartment.

(7) The test item has no integral loading ramps.

3. TEST NR 3

a. Purpose: Determine the suitability of test item for external transport of supplies and equipment.

b. Method:

(1) Facilities for external hook-up were examined.

(2) Various type loads were lifted externally.

c. Results:

(1) The cargo hook release is located on the pilot and co-pilot's cyclic stick. The pilot activates the master switch setting and then pushes the electrical release button on the cyclic stick. The emergency or manual release is located by the pilot's seat. The boat hull of the test item will preclude a hook access door from being installed in the bottom. Unassisted hook-up would have to be accomplished through use of a rear view mirror arrangement. No rear mirror was provided.

(2) The following loads were transported satisfactorily:

Trailer, Water, 2-Wheel, 400 Gal	
M107E2	2,280 lb
M151, ¼-Ton Trk	2,560 lb
M151, ¼-Ton Trk w/Tlr	3,100 lb
2 - A-22 Containers	3,000 lb
Truck, 3/4-Ton, M-37	6,200 lb
Dummy Load	3,500 lb

(3) In addition to the above loads, a 3,000-pound dummy load was dragged 100 yards. Four dummy loads were released from the cargo hook while the test item was in a hover position. No adverse effect on the hook assembly was noted.